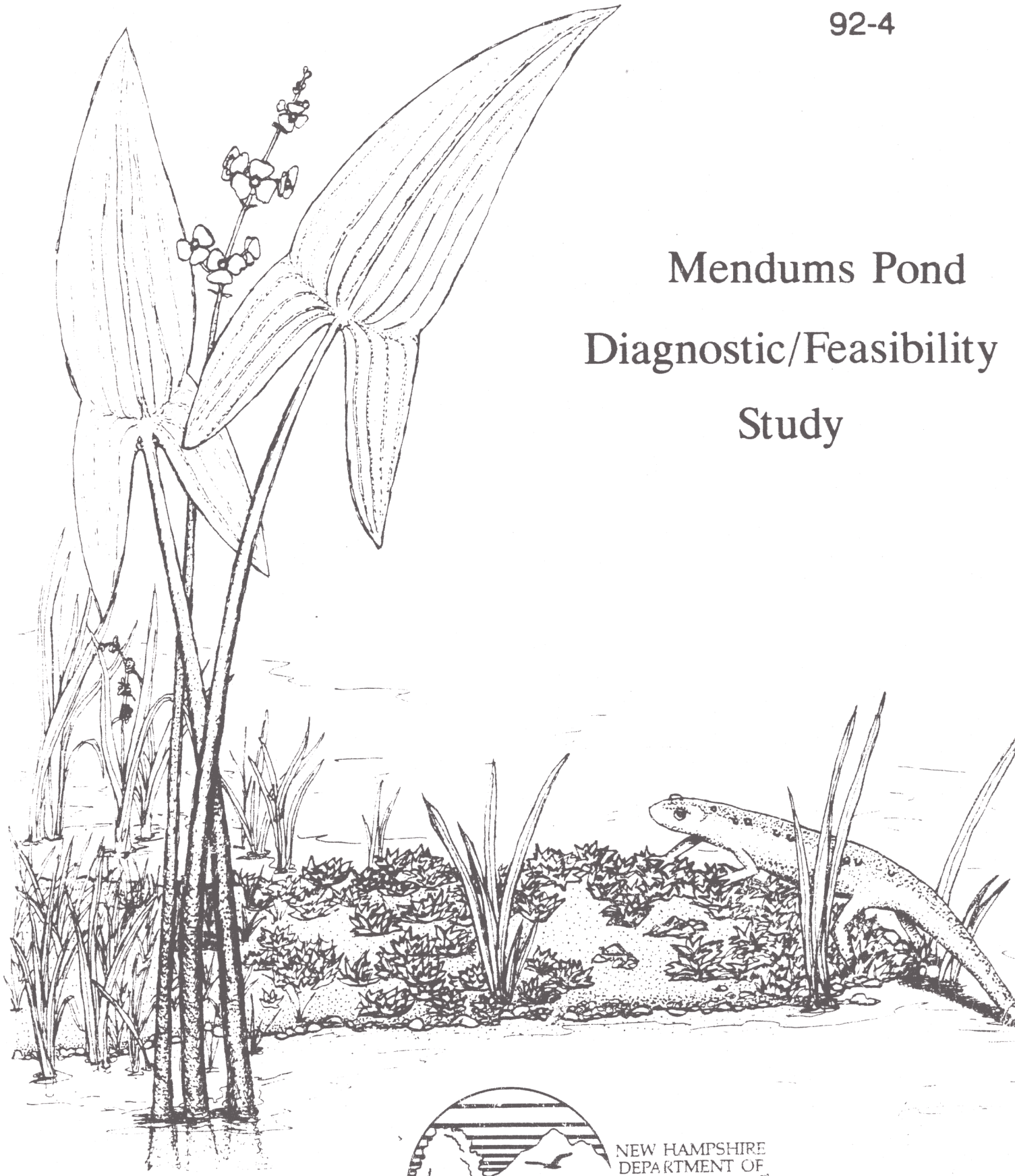
STAFF REPORT

NHDES-WSPCD

92-4

Mendums Pond Diagnostic/Feasibility Study



NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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May 1, 1992

Mr. Warren K. Howard, Program Manager
U.S. Environmental Protection Agency
Region I
John F. Kennedy Federal Building
Boston, Massachusetts 02203

Dear Mr. Howard:

Transmitted herewith is the Phase I Diagnostic/Feasibility Study for Mendums Pond, Barrington, New Hampshire. This report was prepared, in part, under the Clean Water Act, through a Section 314 Environmental Protection Agency grant. This report culminates over 30 months of lake, groundwater and tributary monitoring , watershed evaluations and researching the area's soils for assimilating septic leachate phosphorus. Hydrologic and phosphorus budgets were constructed for each sub-watershed area of the pond. Sediment cores were analyzed to estimate the potential impact of sediment released phosphorus to the water column.

Based on the biological and chemical assessment, and the modeling techniques employed, Mendums Pond falls into the Oligotrophic/Mesotrophic classification scheme. Each of the major phosphorus sources to Mendums Pond were delineated. Because of a sagging economy, lakeshore development decreased and the effects of the proposed development of Mendums Pond could not be documented during the study period.

The feasibility section provided an overview and recommendations for lake protection. The feasibility section focuses attention on decreasing non-point sources of phosphorus to Mendums Pond through watershed protection.

Respectively submitted,

Robert W. Varney
Commissioner

Jody Connor
Clean Lakes Project Coordinator

RWV/JC/pdl

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NEW HAMPSHIRE DEPARTMENT OF Environmental Services

NHDES-WSPCD-92-4

Mendums Pond Diagostic/Feasibility Study

Final Report

May 1992

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ABSTRACT

The Mendums Pond Diagnostic/Feasibility Study presents thirty-four months of data collection from October, 1987 through the summer of 1990. The physical, chemical and biological data collected during the study was utilized to develop a protection scheme for Mendums Pond. This study has greatly improved the limnologists' understanding of the aquatic ecosystem of Mendums Pond.

The study accomplished the following objectives:

1. identified the historical and existing quality of Mendums Pond;

2. identified the inflowing tributary water quality;

3. developed hydrologic and phosphorus budgets for Mendums Pond;

4. documented the significant sources of phosphorus to Mendums Pond;

5. identified sediment phosphorus and metal concentrations;

6. compared trophic models that classified Mendums Pond;

7. reviewed watershed protection measures that will help protect Mendums Pond;

8. documented that the area's soils are not suitable for uptaking septic system phosphorus and the area's geology aids in transporting phosphorus to the lake;

9. provided an extensive data base during a period of little development, to be used as a baseline in the future after additional development occurs.

Because of the sudden economic recession, and the subsequent decrease in development, the study failed to show an impact upon Mendums Pond from the proposed development of a large tract of shoreline property.

The results and recommendations of the Mendums Pond Diagnostic/Feasibility Study provide a basis for lake protection. Although the project has been successful in accomplishing many of the goals, only through the combined efforts of the Town, Lake Association and the State will the recommendations be implemented. Only through implementation of the lake protection recommendations will the project be a complete success.

ACKNOWLEDGEMENTS

The authors wish to acknowledge many individuals whose help and cooperation aided in the completion of this study and final report.

Special thanks to Robert H. Estabrook for his complete support of this special study and his editorial assistance of the report.

The Biology Bureau staff of this Department is acknowledged for its professional assistance in the field and laboratory. Particular thanks go to Kenneth Warren, Walter Henderson, Michael Martin, Kendall Perkins, Douglas Dubis, Donald Thurston and Natalie Landry who spent many hours under adverse weather conditions, recording stream flows, sampling the lake and measuring groundwater seepage. Also, thanks to our summer intern Lisa Cassidy who spent much of her summer doing both the field work and laboratory analyses for this study.

Special thanks go to Douglas Dubis for coordinating the computer data bases and Steve Landry for producing some of the computer graphics. The efforts of Garry Haworth for coordinating the four year chemical analyses program was greatly appreciated.

Members of the Citizen Advisory Committee (C.A.C.) are thanked for their participation in the study, and for their concern and dedication in the protection of Mendums Pond. Joanne and John Sasner were especially instrumental to this report in allowing the Biology Bureau to have monitoring wells installed on their property.

We appreciate Gracy Haley for the use of her property to store our boat and equipment.

Thanks to Marianne O'Loan for her exceptional artistic skill in the production of the final cover scheme.

We are grateful to Region I of the United States Environmental Protection Agency for their financial assistance, and particularly Warren Howard for his support and guidance during all phases of this project.

Lastly, a most appreciative thanks goes to Paulette LaRamee for her many hours of typing this document, as well as her insight and persisting efforts to arrive at an organized and impressive report.

MENDUMS POND
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EXECUTIVE SUMMARY

A. Introduction

As part of Section 314 of the Clean Water Act, a Diagnostic/Feasibility Study was conducted at Mendums Pond, Barrington N.H. Mendums Pond is a relatively undeveloped oligotrophic pond, whose shoreline is becoming more populated as a result of moderate development on the Western shore. Monitoring the pond quality and it's tributaries before, during, and after construction can help biologists determine the effects of this activity on similar lakes and ponds.

B. Study Approach

Before recommendations could be made concerning possible measures to protect the pond from proposed development, a greater understanding of the pond's flushing rate, groundwater influences, watershed utilization, sediment characteristics and nutrient sources had to be investigated. To this end, biologists undertook an intensive study to document the physical, chemical and biological processes of the pond.

1. Physical, Chemical and Biological Monitoring

Measurements of water chemistry, plankton and periphyton populations, chlorophyll-a and transparency were recorded. A dye study was implemented to monitor leachate water movement through the parent soil. An inventory of macrophytic growth was documented, and a detailed map and evaluation of the pond's littoral areas was completed. Sediment cores were extracted and analyzed for specific metals and phosphorus. Land use, topographical ground cover, and soils maps for the entire watershed were prepared.

2. Hydrologic Budget

The hydrologic budget for the study period 1987-1988 quantified all significant sources of flow into and out of the pond through gaging of the tributaries and outlets, estimating direct surface runoff into the ponds, measuring precipitation and evaporation, and estimating groundwater seepage rates.

3. Nutrient Budget

Concentrations of phosphorus, the primary factor limiting plankton growth, were determined through pond sampling and analysis for many of the sources documented in the hydrologic budget. Groundwater, atmospheric dryfall and direct runoff inputs were estimated. Phosphorus loading to the lake from near-shore septic systems was also estimated. Finally, the quantity of phosphorus in both the water column and the sediment was determined. A nutrient budget was then prepared for the study year.

4. Lake Modelling

The determination of the trophic state of a lake involves a comparison of the actual total phosphorus loading to the lake with the maximum load that the lake can tolerate before trophic state declines. A trophic state model is a mathematical relationship which, by incorporating such factors as phosphorus loading and hydraulic retention time, allows a lake to be classified as oligotrophic, mesotrophic, or eutrophic. Four classification schemes were selected and compared for this study.

C. Study Results

1. Chemical and Biological Properties

Mendums Pond is a dimictic lake, that exhibits an oxygen deficiency during October. Tributaries tend to be more acidic than ponds in New Hampshire. In this study tributary pH ranged from 4.32 to 6.37 while pond epilimnetic values ranged from 5.25 to 7.25 with a median of 5.76.

Alkalinity in the tributaries ranged from -2.40 mg/L in the winter in Golden Brook to 6.80 mg/L in the fall in Little Bridge Brook. In general, the lowest alkalinities occurred in the spring, the highest in the fall. In-lake (epilimnetic) alkalinities ranged from 0.80 mg/L to 1.40 mg/L.

Specific conductance ranged from 19.67 umhos/cm in Perkins Brook to 66.50 umhos/cm in Storm Brook. Conductivity in the pond's epilimnion ranged from 21.80 to 32.43 umhos/cm.

Chloride concentrations were low at all stations, except for Storm Brook, which ranged from 11 mg/L to 23 mg/L. The values for other tributaries and the pond ranged from 1 mg/L to 10 mg/L which are more typical of New Hampshire surface water. Little variation was apparent at any station over time or on any particular sample date.

Sulfate concentrations were low at each station, ranging from 0.4 mg/L to 8.4 mg/L. Little variation was apparent at any station over time or between stations or on any particular sample date.

The lowest tributary color was most often observed in Storm Brook, with a mean color of 15 CPU. The highest values were found in Golden Brook, with an average color of 241 CPU. In-lake color ranged from 22 to 65 CPUs.

Total phosphorus concentrations were highest in Perkins, McDaniel, Bridge, and Little Bridge Brooks. The medians for these brooks ranged from 24 to 45 ug/L. Other tributaries had typical phosphorus concentrations found in New Hampshire surface waters.

Throughout the entire study period, in-lake total phosphorus concentrations ranged from below detection to 25 ug/L, with a median of 9 ug/L. There was no marked increase in the hypolimnetic concentrations at any one time, indicating that the sediments were not a major source of phosphorus.

Nitrate nitrogen was low at each station. Generally, concentrations were below detectability limits (0.05 mg/L).

Mean Total Kjeldahl Nitrogen (TKN) concentrations in the major tributaries ranged from 0.09 mg/L in Little Powerline Brook to 0.68 mg/L in Little Bridge Brook. Mean in-lake TKN ranged from 0.30 mg/L in the hypolimnion to 0.45 mg/L in the epilimnion.

Phytoplankton densities ranged from 127.4 cells/mL to 1231.2 cells/mL. Chlorophytes (tiny flagellates) were dominant for the majority of the sample dates. Bluegreens (Merismopedia spp) were dominant on September 11, 1987 and on three sample dates in late summer/early fall, 1988. The diatom Asterionella was dominant on May 16, 1990.

The rotifers Keratella and Kellicottia were the most common zooplankton in Mendums Pond.

Chlorophyll-a concentrations ranged from 1.28 mg/m^3 on December 3, 1987 to 9.67 mg/m^3 on April 28, 1989 (a documented diatom bloom). The 1988 summer mean chlorophyll-a concentration was 2.95 mg/m^3

2. Hydrologic Budget

A hydrologic budget was prepared for the Mendums Pond watershed utilizing an intensive one-year stream gaging program. All measurable in-coming and out-going parameters were budgeted.

Perkins Brook was the greatest single source of water to Mendums Pond, supplying 55 percent of the tributary inflow to the pond.

Tributary flow accounted for 83 percent of the total inflowing water to Mendums Pond. Lesser amounts of water inputs to the hydrologic budget were attributed to direct lake surface precipitation (10%), direct surface runoff (4%) and groundwater seepage (3%).

3. Phosphorus Budget

An important goal of this study was to quantify the various avenues of phosphorus inputs to Mendums Pond. Chapter VIII provides an annual phosphorus budget for the study year.

The greatest single contributor of phosphorus to Mendums Pond was Perkins Brook which contributed 27 percent of the total budget and 53 percent of the tributary phosphorus load.

Inflowing tributaries contributed 178 Kg of phosphorus or 50 percent of the total lake load. Septic system leachate was responsible for 67 Kg or almost 19 percent of the phosphorus load while direct surface runoff added 14 percent, atmospheric contributed 12 percent and groundwater seepage transported five percent. While 357 Kg of phosphorus entered the pond, only 64 Kg left the pond via the outlets. It is apparent that Mendums Pond is a large sink or accumulator of phosphorus. The ponds sediments are probably the largest single assimilator of phosphorus.

4. Lake Modelling

A summary of the four classification schemes utilized in this study revealed that the New Hampshire Lake Classification System, Carlson's Trophic Status Index (TSI) for phosphorus, and the Dillon/Rigler model all classify Mendums Pond as oligotrophic. The Carlson's TSI for chlorophyll-a and Secchi disk transparency both classify Mendums Pond as a borderline oligotrophic/mesotrophic lake. The Vollenweider model classifies Mendums as mesotrophic.

On a permissible loading basis, the Dillon/Rigler model demonstrated that it would take an additional load of 88 Kg of phosphorus to decrease the classification from oligotrophic to mesotrophic.

D. Feasibility

Lake protection and watershed management are the most feasible methods for preserving Mendums Pond. The most feasible means of lake protection and watershed management should include the following measures:

1. Shoreland protection ordinance
2. Community education program
3. Watershed Zoning
4. Pumping and inspection program for subsurface systems
5. Wastewater treatment alternatives
6. Education program for hobby farms
7. Volunteer watershed monitoring
8. Best Management Practices program for silviculture
9. Stormwater runoff management
10. Volunteer lake monitoring/Phase I Implementation evaluation